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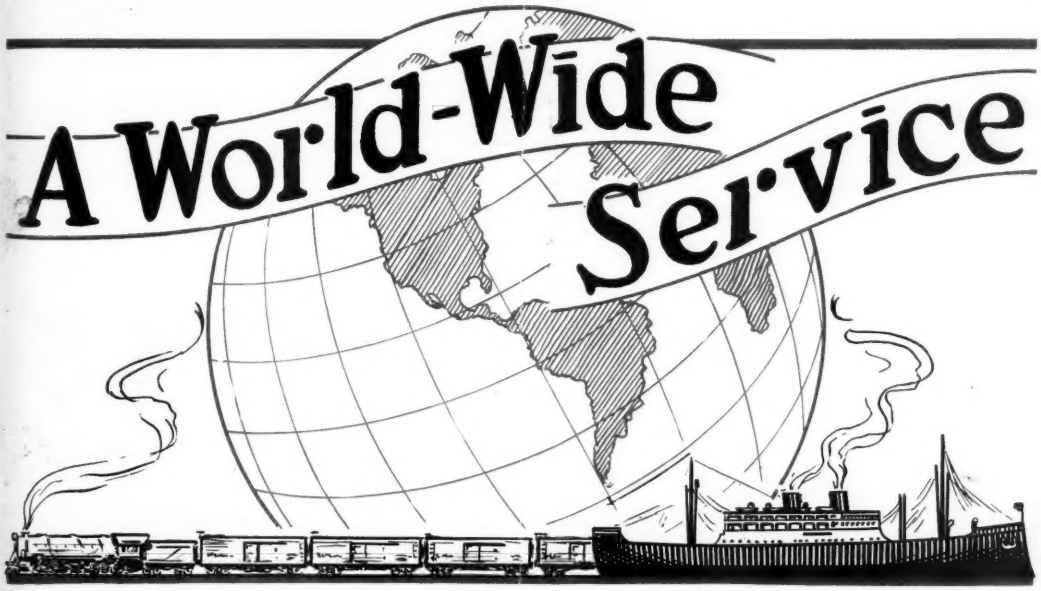
The American Fertilizer

MARCH 1, 1941 No. 5



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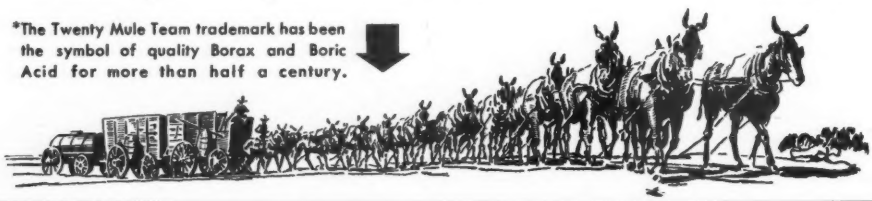

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Vol. 94 MARCH 1, 1941 No. 5

The Egner Lactate Method for Phosphate Determination

By H. EGNER

IN the search of a simple laboratory method, which will give the same information about the phosphate fertilizer requirements of cultivated soil as do reliable field experiments, it was found desirable to consider the following points (the order of which has nothing whatsoever to do with their relative importance):

1. The *soil volume* in the field must be accounted for. As laboratory methods give *weight* per cent, it is necessary to make a determination of the volume weight of the soil, and to know the depth of the vegetable mould down to the subsoil. The latter is easily estimated when the samples are taken; the former might be determined with sufficient precision and very cheaply by means of the apparatus shown in Fig. 2 and 3. For soils very rich and very poor in phosphates these determinations might be omitted.

2. *Soil classification* in three or four groups according to the clay content of the soils might be helpful and give a better correlation between the laboratory method and the field experiments. A rough classification sufficient for this purpose can be made very easily by observing the color, testing and general appearance of the sample, a rolling test, etc. Such a grouping, therefore, costs very little. The same is true, in a still higher degree, of a classification according to crop. When more experience is acquired, it is planned to try a detailed grouping, e.g., according to farming district, content of organic matter, and pH value.

3. The laboratory method ought to give an amount of from 1 to 10 mg. of soluble P_2O_5 per 100 g. of soil. If recalculated to field conditions, these figures enclose what must be the critical range, for the following reasons: (a) it corresponds to the amount of phosphorus taken up by a single crop; (b) a normal quantity of farm manure or artificial fertilizer will add an amount of phosphorus within the same range, and we know that such a quantity will change a poor soil into a rich one with regard to this element; (c) the amounts taken up or calculated according to the more or less physiological methods of Mitscherlich and Neubauer also fall within the same range. It seems reasonable to assume, therefore, that methods giving considerably higher or lower amounts of soluble phosphorus will give less reliable results, and be more affected by other factors than the phosphate figure. Methods based on the use of strong acids, and those using citric acid, for instance, give considerably higher figures than those mentioned above, the lower limit for citric acid extraction usually being put at about 25 mg. P_2O_5 per 100 g. of soil. On the other hand, methods using pure water or carbonic acid solutions, e.g. Dirks and Scheffers method, give very much lower results, if reasonable amounts of the extraction medium are used.

4. As to the experimental procedure, some demands on an ideal method must be kept in mind. Repeated extractions, too large a proportion between the amounts of extraction medium and soil sample, corrections in the composition of the extraction medium depending upon the composition of the soil (e.g., lime content), and too small soil samples used in the extraction, making it difficult to get them representative, are all undesirable features, which ought to be avoided as far as possible.

Extraction media which, in themselves or by dissolving large amounts of humic acids from the soil, cause difficulties or make extra arrangements in the analytical procedure necessary, should also be avoided. Here, among others, citric acid is far from ideal. Water extracts, particularly of heavy soils, are sometimes very difficult to filter.

5 The extraction medium ought to be well buffered in its reaction value, as the solubility of phosphoric acid is well known to be highly dependent upon the pH of the solution. From this standpoint, pure acids are less suitable than buffer mixtures, as they are poorly buffered against small additions of alkali. The

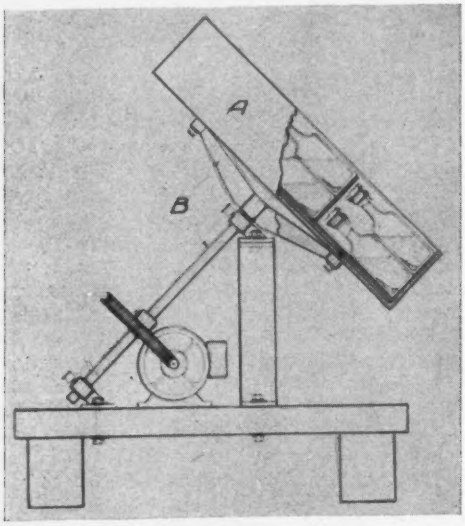

FIG. 1. A is a square box, 70 x 70 x 15 cm. (28 x 28 x 6 in.) which is divided into compartments. Each compartment holds two bottles of about 1 qt. capacity each. A is fastened on shaft B which is set on a 45° angle and rotates 7 revolutions per minute. A box of the above given dimensions will hold 36 bottles; we also used a larger box which held 144 bottles.

same is true of water. As has been pointed out by Truog, pure water is far from being a natural extraction medium for soils, as the soil solution contains a multitude of salts, active colloidal matter, and carbonic acid.

6. The extraction medium ought to contain some complex-forming substances in a suitable concentration. The solubility of phosphoric acids is not only dependent upon the pH of the solution, but to a rather high degree upon the presence of such substances as sulphuric and citric acid (cf. Gaarder), probably depending upon the power of the latter to form complexes with aluminum, iron, etc., thus shifting the equilibrium in the mass action equation towards higher concentrations of phosphoric acid. In the soil solution, carbonic acid, humic acids, and probably silicic acids might be expected to play the same role.

7. Still another factor, which must be considered, is the ionic strength of the solution. It is well known from the work of Cohn, and Bjerrum and Unmack that the ionization-constants of phosphoric acid vary quite considerably with the ionic strength, as must also be expected according to the new theories of strong electrolytes. From this, one might safely conclude that also the solubility of the phosphates in soils must vary with the ionic strength of the extraction fluid. To get comparable results from different soils on the solubility of their phosphates, it seems natural, therefore, to demand that the extraction medium is well buffered in this respect also. This is not the case with pure acids, still less with distilled water.

Extraction Media

Keeping in mind the considerations briefly outlined above, a number of extraction media were tried. Although buffer mixtures of carbonic and acetic acid were also investigated, the interest of the author soon was concentrated upon buffers containing sulphuric and lactic acid, or both of them. Their composition and concentration, the proportion between soil sample and amount of extraction medium, and time of shaking was varied. A statistical study of the results of this investigation has been made by O. Franck of the Agronomy Department of this station (15).* This paper, therefore, has been restricted to an account of the facts and principals utilized in the search of a suitable method, and a rather detailed description of the method which up till now has given the best results.

The general procedure used in sifting out the various methods tried, besides taking into consideration the seven points outlined above, was, first, to compare the results obtained for a few typical and well known soils with the results of field experiments and Mitscherlich pot tests, both of them having given very nearly the same results (34). If the correlation seemed reasonably good, further extractions were made with more or in some cases all of the 127 soils, for which Mitscherlich values (and reliable field experiments) were available. In this way, two methods were sifted out, one using a sulphuric acid, another a lactic acid buffer. The former had the following

* Figures in parenthesis refer to Literature References at end of article.

composition: 0.005 *N* H_2SO_4, 0.015 *N* $(NH_4)_2SO_4$, and had a pH of 2.4; the latter 0.02 *N* Ca lactate, 0.01 *N* HCl, with a pH of 3.5 The experimental procedure was identical in both methods, with the self-evident exception that no lactate was used in the standards for the sulphate method. A description of the lactate method follows.

Five grams of air-dry soil, which had been driven through a sieve with a sieve opening of 2 mm. (approximately No. 8 mesh) was transferred to a shaking bottle. Ordinary soda water bottles with a capacity of 400 ml., and patent stoppers were found to be very convenient. When 20 to 30 samples had been weighed (with a longer series, attention must

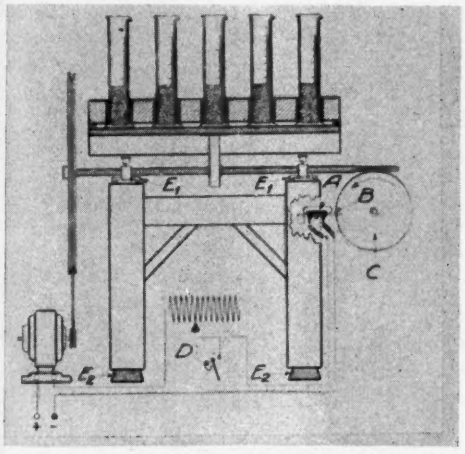

FIG 2. Shaking machine to determine the apparent density of samples of earth; front elevation. Pin B on gear wheel C operates mercury trip switch A, which breaks the current to the motor. As the gear ratio between the shaft of the shaking machine and C is 1:200, the machine will automatically shake 200 times and then stop. This is done by closing switch D when pin B has just passed the trip switch A. E1 and E2 are shock absorbers of cork. The speed of the machine should be about one stroke a second and the height of the fall about 5 cm. (2in.)

be paid to the time used in filling and filtering, to avoid significant differences in the time of extraction), 250 ml. of lactate buffer was added to each bottle, by means of an automatic self-filling pipette attached to a storage bottle. The bottles were closed, and shaken for two hours in the shaker shown in Fig. 1. The shaker is very easily loaded, as it is not necessary to use any clamps, and will give a rather thorough shaking even at the slow rate of 7 to 10 revolutions per minute. It is of the same type as that used by O. Arrhenius, but with the very important modification that the bottles are lying instead of standing on the bottom of the box. The extraction in all our experiments was carried out in a constant temperature room, the temperature of which was kept at 20°±0.1° C. (68° F.). After two hours shaking, the suspensions were filtered. As it is imperative to have clear filtrates in the subsequent colorimetric estimation of phosphoric acid, it is best to use a hard filter paper. Schleicher and Schull's 15 cm. No. 605 (folded) or 602 have been used with very good results, the former being a little more convenient. The first filling is thrown away, thus making it unnecessary to dry the funnels and receivers between every filtration.

Of the clear filtrate, 25 ml. is pipetted into a 50 ml. medicine bottle of clear white glass. A series of uniform bottles should be selected.

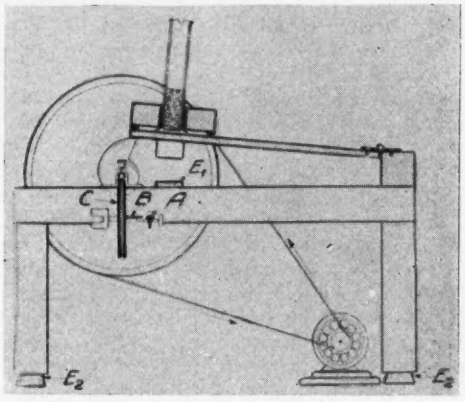

FIG. 3. The shaking machine pictured in Fig. 2 viewed from the side.

The pipett may have a broken nib and very short delivering time in order to permit rapid work, as the precision in the following color estimation is not carried out to less than about five per cent. The pipette must be rinsed with water between every test, however, as otherwise a rich sample might cause a considerable error in determining the phosphate content of a subsequent poor one.

The following stock solutions have been prepared beforehand:

A. *Lactate buffer.* One-half g.-mol of pure calcium lactate (as used for pharmaceutical purposes; as the water content varies somewhat, it is best to analyze the sample by ashing about 1 g. in a platinum crucible, boiling the crucible content in excess dilute titrated hydrochloric acid in a beaker, and titrating; a g mol will weigh about 300 g.) is transferred to a tall 2 liter beaker, and dissolved in 1 liter of boiling water. One-half g.-mol of hydro-

(Continued on page 22)

European Potash Situation

ACCORDING to the German Mining Journal of October 26, 1940, the German Reich has assumed control of the Alsatian potash mines that had been French Government property since the Treaty of Versailles and now is administering them temporarily through a commissary.

The repossession of these mines by Germany, it is said, is likely to be followed by a transfer of the mines to their former German owners—11 mining companies whose holdings were appraised officially at 220,000,000 reichsmarks at the time when they were turned over to the French State on the basis of the Versailles Treaty. These companies received only a nominal indemnity from the Reich totaling about 15 per cent of the officially appraised price. After the World War the mining companies invested considerable capital in oil drilling. (Commercial Attaché Sam E. Woods, Berlin, Oct. 29, 1940.)

By reference to other sources of information regarding Alsatian potash, it is evident that, although Germany has hastened to re-establish control over the potash operations, it is finding it difficult to reinstate the industry. Before the present war a great part of the Alsatian output was exported—in 1929, 264.000 metric tons of a total of 494,000 tons; in 1936, 166,000 tons of a total of 387,000 tons; in 1937, 218,000 tons of 478,000 tons; and in 1938, 272,000 tons of 572,000 tons. The Alsatian potash producers were then under agreement with the German producers to divide the export market and give 30 per cent to France and 70 per cent to Germany. Now, however, even though the producing fields may have agreed to maintain this percentage, Germany is having difficulty in exporting its own potash. The potash deposits of Alsace are smaller than those of Germany, its reserves having been estimated at about 300 million metric tons of pure potash, compared with more than 7 billion tons in the north and central German deposits. The Alsatian material has a high potash content and can yield 12 to 15 per cent crude salts and even 20 per cent fertilizer salt for use as fertilizer without processing. In addition to lack of export outlets, labor is scarce, transportation difficult, and other problems connected with the war present obstacles. Nevertheless, Germany is making every effort to reincorporate the potash industry of Alsace with the German industry. Before 1919, it was said, all of the Alsatian potash mines except those now held by the Kaliwerke St. Therese A. G. were controlled by the Wintershall A. G., either directly or through mergers. It now seems likely that these mines (which represent the greater part of the industry) will again revert to Wintershall. It is not apparent what disposition will be made of the privately owned Kaliwerke St. Therese A. G.

Situation in Germany

Based on what is believed to be reliable information, it appears that numerous factors have been hindering progress in the potash industry in Germany proper. Aside from the drastic curtailment of exports, which before the present war took about 25 per cent of Germany's output, other difficulties have arisen. Military operations have drawn labor away and created a scarcity not only in the mining end but also in the industries that would furnish new and replacement equipment. Railroad transportation is inadequate and fuel scarce. In the first part of 1939, moreover, two of the main producing mines (the Königshall-Hindenburg mine of the Burbach Kaliwerke A. G., and the Rossleben mine of the Vereinigte Kaliwerke Salzdetfurth) suffered considerable financial loss through flooding, which closed the mines for considerable time. Despite the difficulties, however, potash output in 1939 hit an all-time high record, although, because of increased producing costs, the net profits in general decreased slightly.

Data for 1940 are not available, but decreased production is indicated. This decrease is due mainly to loss of overseas markets, which has been offset only partly by increased domestic consumption and exports to nearby countries. Sales of potash for fertilizers have been pushed, not only in the German market but in the agricultural countries in Europe that have heretofore not been great users of potash for fertilizer. The potash market in the Balkan countries, now under German political and economic control, is being expanded. These countries are expected to increase their agricultural crops to supply Germany, which now produces too little for domestic consumption, and they are being instructed in the large-scale use of potash and other modern agricultural methods for stimulating production. It works both ways.

In recent years the leading potash companies of Germany have developed other lines

requiring investments of capital. In March, 1940, to meet its financial commitments in its rapidly expanding projects, the Wintershall A. G. floated a loan of 50 million marks, bearing interest at 5 per cent, to mature in 18 years. This company has undertaken to produce synthetic motor fuel, has invested in oil fields in Austria, and has invested in a string of filling stations, although under the wartime conditions this would not have appeared profitable. The company has also operated jointly, for years, an iron and coal company together with other side-lines. It has extended its interests in the production of magnesium metal. At first it was interested only in producing the crude metal and its alloys, but recently it has gone into production of processed or semi-finished magnesium products.

Although it is now thought likely that the German potash interests will resume control of such interests in the Alsatian potash industry as they had previous to 1919, apparently it will not solve any of the difficulties, as the problems to be faced in Alsace are similar to those of Germany.

POTASH DELIVERIES DURING 1940

The American Potash Institue, Inc., announces that deliveries of agricultural potash of domestic and foreign origin within the continental United States, Canada, Puerto Rico, and Hawaii during the calendar year, 1940, amounted to 444,078 tons of actual K_2O, equivalent to 797,222 tons of potash salts. Constituting this total were 673,483 tons of muriate, 18,077 tons of manure salts. 67,453 tons of sulphate, 3.532 tons of sulphate of potash magnesia, and 34,677 tons of kainit. In addition, deliveries for chemical uses amounted to 61,335 tons of salts equivalent to 38,028 tons of K_2O.

Potash Deliveries of Domestic and Foreign Origin
Short Tons K_2O
(United States, Canada, Cuba, Hawaii, Puerto Rico)

	Calendar Year 1940	Calendar Year 1939
Muriate, 60 + 50%	397,505	323,587
Manure salts, 30 + 25%	5,265	6,528
Kainit, 20 + 14%	6,866	4,734
Sulphate	33,463	26,133
Sulphate of potash magnesia	979	4,073
Total Agricultural	444,078	365,055
Chemical potash	38,028	24,284
Grand Total	482,106	389,339
Northeast-Middle Atlantic States	101,482	78,118
Southern (including Va.)	217,514	195,149
Mid-Western	66,808	47,009
West Coast	7,815	5,220
Canada, Puerto Rico, Cuba, Hawaii	50,459	39,559
Total Agricultural	444,078	365,055

In terms of regional consignments the total of 393,619 tons K_2O delivered within the continental United States was shipped as follows: Northwestern and Mid-Atlantic States, 101,482 tons; Southern States (including Virginia), 217,514 tons; Midwestern States, 66,808 tons; and West Coast States, 7,815 tons. The balance of 50,459 tons K_2O was delivered to Canada, Cuba, Puerto Rico, and Hawaii.

MATERIALS USED IN THE FERTILIZER INDUSTRY

The U. S. Bureau of Census has released statistics on the amount of various materials used in the production of fertilizers during 1939. Compared with the peak year of 1937, there is a decrease in almost every item.

Materials Consumed, by Kind and Quantity, 1939 and 1937

Kind	Tons (2,000 lbs.) 1939	Tons (2,000 lbs.) 1937
Used in manufactuse of fertilizers:		
Sulphate of ammonia	339,590	380,536
Nitrate of soda	87,793	122,821
Ammonia, anhydrous	13,047	26,360
Ammonia, aqua, basis 25% NH_3	77,289	58,060
Calcium cyanamid	34,779	44,157
Urea and calurea	16,305	33,633
Ammonium phosphate	27,356	32,793
Cal nitro	45,145	(1)
Other inorganic nitrogenous materials	69,476	79,036
Cottonseed meal	75,903	78,730
Tankage (processed)	92,638	124,796
Tankage (animal) and dried blood	53,951	40,471
Tankage (garbage)	31,091	55,501
Fish scrap and meal	39,067	98,189
Guano (all kinds)	27,063	27,536
Sewage sludge	17,300	24,110
Other organic nitrogenous materials	175,462	174,568
Bones, ground, steamed, etc.	15,775	32,763
Superphosphate, basis 16% A. P. A., total	2,816,537	3,495,659
Quantity made during year used in mixed fertilizers	1,395,302	2,163,147
Quantity purchased or taken from previous year's stock used in mixed fertilizers	1,421,235	1,332,512
Muriate of potash, basis 50% K_2O	496,703	524,606
Sulphate of potash	56,389	57,889
Manure salts, basis 20% K_2O	31,083	83,597
Kainite	19,434	20,703
Other potash-bearing materials	66,066	58,857
Other materials containing plant food	268,859	363,337
Phosphate rock	2,029,060	2,306,396
Sulphuric acid purchased and consumed	717,360	880,583
Sulphuric acid made and consumed, basis 50° Baumé, total	1,161,770	1,305,174
Contact process	163,180	52,041
Chamber process	998,590	1,253,133
Phosphoric acid, total	119,754	(1)
Phosphoric acid purchased and consumed	12,002	(1)
Phosphoric acid made and consumed, basis 50% P_2O_5	107,752	(1)

[1] No data.

Liebig and Our Nitrogen Industry*

By F. S. LODGE

Technical Assistant, The National Fertilizer Association, Washington, D. C.

HAD the theories advanced by Liebig as to the role of nitrogen in plant nutrition been correct, it is doubtful whether we would now have a nitrogen industry, except possibly for the production of explosives. When he made his famous address to the British Association in 1840, he propounded the theory that all the nitrogen consumed by plants came from the decomposition of animal and vegetable matter. He believed the nitrogen of passing generations was utilized by succeeding ones.

He stated that the processes of decay transformed the various nitrogen compounds contained in animal bodies into ammonia. Such of this ammonia as was not absorbed in the soil, escaped into the air in the form of gas, to be in turn absorbed and returned to the soil in rain and snow water, to furnish plants the nitrogen necessary for growth. There was no doubt in his mind, for in the 1840 edition of his "Organic Chemistry in its Applications to Agriculture and Physiology," he says: "No conclusion can then have a better foundation than this, that it is the ammonia of the atmosphere which furnishes nitrogen to plants."

"It is worthy of observation, that the ammonia contained in rain and snow water, possessed an offensive smell of perspiration and animal excrements—a fact which leaves no doubt respecting its origin."

In order to support his theory, he made many analyses to determine the ammonia content of rain water. These analyses were too high as shown by contemporary analyses of others and by those of the present day. He offered the natural growth of forests and weeds as proof that sufficient nitrogen was returned to the soil in rain water to support natural vegetation. Because nitrogen was constantly removed from the soil by harvested crops, he believed and stated in 1840 that additional supplies of nitrogen must be added to cultivated soils to maintain their fertility.

He disposed of the humus theory of plant nutrition to his own satisfaction by announcing that "humus supplies young plants with nourishment by the roots, until their leaves are matured sufficiently to act as exterior organs of nutrition; its quantity heightens the fertility of a soil by yielding more nourishment in the first period of growth and consequently by increasing the number of organs of atmospheric nutrition."

His views changed from time to time as his own experiments and the results of research by others furnished him additional data upon which to base conclusions. By the time the second edition of his "Organic Chemistry" came out in 1843, he was thoroughly convinced that rain water returned to the soil sufficient nitrogen to supply the needs of many of the cultivated crops.

His theories on nitrogen were vigorously challenged by some of his contemporaries and as vigorously defended. His mineral theory was said to have been evolved to explain why the addition of nitrogen-bearing chemicals to soils increased crop yields. Such increases he claimed were caused by elements, other than nitrogen, that were included in the nitrogen-bearing chemicals, and which were necessary to enable plants to utilize nitrogen effectively.

Bitter controversies on this subject continued throughout his life and he continued to advance new explanations and to contest the statements of his opponents. He disposed of Lawes' and Gilbert's work on nitrogen as follows:

"The experiments of Messrs. Lawes and Gilbert are very far, indeed, from proving the conclusions which they wish to draw; they establish rather the fact that these gentlemen have not the slightest notion of what is meant by argument or proof."

In later years, apparently hard pressed to maintain his rain-water-nitrogen theory in the face of data obtained by other analysts whose reliability he could not question, he somewhat expanded his concept of nitrogen sources. In his "Natural Laws of Husbandry," published in London in 1863, he says:

"But plants receive ammonia and nitric acid not merely by means of rain water derived from the ground and in dew, but also directly from the atmosphere."

"Although we can estimate with tolerable certainty the quantity of ammonia and nitric acid which a field annually receives in rain water, yet the determination of the same in the dew which moistens plants is not practicable."

* A paper presented at the "Liebig Symposium," American Chemical Society meeting, Detroit, September 9-13, 1940.

"And we may assume, without risk of error, that the plants which grow in the cultivated fields of Europe have as much ammonia and nitric acid furnished them by the air and the dew as is conveyed to them in rain water."

We find no record in his writings that he ever abandoned his theory that plants could and did receive their necessary nitrogen from the rain water, the dew, and the atmosphere direct. His challenging and uncompromising attitude toward those of his contemporaries who held different views undoubtedly stimulated them to even greater research efforts on the problems involved in order to disprove his theories. This spur to factual investigation was perhaps Liebig's greatest contribution to the study of nitrogen.

Some of Liebig's conclusions have stood the test of time. That plants do receive some of their nitrogen from rain water and dew, and that some plants are capable of obtaining their nitrogen needs from the atmosphere became accepted facts. However, that the economic phases of agriculture require the application of additional compounds to soils used for the production of most crops also has become accepted fact.

Nitrogen Fertilizers

Although manures and other organic carriers of nitrogen had been used in crop production in this country for many years, the first importation of nitrate of soda into the United States in 1830 may be said to have started the commercial use of nitrogen in our agriculture. Commercial importation of Peruvian guano began in 1840, and its consumption increased rapidly until 1854, when importations reached an all-time maximum of 175,849 tons.

For forty years more, these two imported materials—nitrate of soda and guano—supplemented by organic by-products such as packing house tankage, dried blood, fish scrap, and by-product vegetable meals, furnished practically all the nitrogen for our agriculture. In 1893 the first recovery of by-product ammonia from the coking of coal was undertaken in this country. By 1900 the production of by-product sulphate of ammonia amounted to 136,000 tons. In that same year the importation of nitrate of soda from Chile reached 226,000 tons. The use of inorganic sources to furnish agriculture its requirements of nitrogen became more and more important, and materials from organic sources were gradually supplanted. By 1912 the tonnage of inorganic nitrogen used as plant food was fully as large as the tonnage of organic.

The ratio of inorganic to organic has steadily increased since that time, until in 1939 approximately 85 per cent of fertilizer nitrogen was of the inorganic form. In that year some 384,275 tons of nitrogen were consumed in this country as plant food—53 per cent in fertilizer mixtures and 47 per cent applied direct, unmixed. The principal reason for this steady increase in the use of inorganic nitrogen is its lower price. In the earlier days, when the chemical reactions taking place in the manufacture of fertilizer were neither perfected nor understood, the mechanical condition of the resulting mixtures was often none too good. The product was likely to resemble either a good grade of putty or a concrete block. The natural organics, such as cottonseed meal and tankage, were excellent conditioners, and their extra cost was considered merely a form of insurance that the goods would be in drillable condition when received by the farmer. In those days, too, odor and color were valuable attributes in promoting the sale of fertilizers. Many of our farmers believed there was some special value in a dark-colored, evil-smelling type of fertilizer. Today many of our best-known agronomists tell us that one form of nitrogen is as good as another as food for plants, provided their acid or basic residual reaction in the soil is made the same.

Manufacturing methods and chemical reactions have now been perfected so that just as satisfactory mechanical condition can be obtained and maintained in mixtures using inorganic sources of nitrogen as in those using natural organics. The farmer has enlightened himself so that he now buys on chemical analysis and watches the results of his fertilizer use. In nearly all cases a unit of inorganic nitrogen is much cheaper than a unit of natural organic. Because of its higher cost and because it is no longer necessary as a mechanical conditioner in fertilizer mixtures, organic nitrogen has been largely replaced by inorganic.

There may be some crops that respond somewhat better to organic forms of nitrogen, and in extremely light and sandy soils in times of heavy rainfall organic nitrogen may prove to be very superior to the more soluble inorganic forms which tend to leach out and be lost under such conditions. By and large, however, inorganic nitrogen is considered to be as satisfactory a plant food as organic nitrogen.

Sulphate of ammonia continues to be our largest source of fertilizer nitrogen. In 1939 there were approximately 100 by-product coke plants operating some 13,000 ovens, which

(Continued on page 26)

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Exports and Imports Decrease During 1940

Exports and imports of fertilizers and fertilizer materials in 1940 were both at the lowest levels reached in the last several years. The decline which began in fertilizer foreign trade in September, 1939, following the outbreak of war in Europe, continued through 1940.

Total exports last year amounted to 1,283,000 long tons, with a stated valuation of

United States Exports and Imports of Fertilizer and Fertilizer Materials by Classes—Total for All Countries—Long Tons

Exports

(Summarized by The National Fertilizer Association from Dept. of Commerce Preliminary Reports)

	Calendar Year		
	1940	1939	1938
Ammonium sulphate	150,852	46,664	30,716
Other nitrogenous chemicals†	100,018	111,575	158,621
Nitrogenous organic waste ..	6,735	12,542	19,153
Total nitrogenous materials	257,605	170,781	208,490
High-grade hard rock	153,110	132,983	181,920
Land pebble rock	602,885	816,023	958,921
Total phosphate rock	755,995	949,006	1,140,841
Superphosphate	141,280	95,224	90,237
Other phosphate materials ..	11,924	29,080	33,074
Total phosphate materials..	909,208	1,073,310	1,264,152
Potash fertilizer materials ..	83,089	122,098	75,122
Concentrated chem. fertilizers	25,569	22,676	16,025
Prepared fertilizer mixtures	7,272	6,201	4,788
Grand Total	1,282,743	1,395,066	1,568,577

Imports

	Calendar Year		
	1940	1939	1938
Ammonium sulphate	42,234	110,761	120,837
Ammonium nitrate mixtures	15,596	65,710	67,497
Calcium cyanamid	118,363	132,698	119,120
Calcium nitrate	1,377	19,255	28,356
Guano	785	5,151	15,199
Dried blood	11,635	13,847	6,115
Sodium nitrate	664,421	604,390	577,130
Urea and calurea	0	836	1,817
Ammonium phosphates	44,782	34,995	29,028
Tankage	12,539	12,148	9,845
Castor bean pomace	6,297	22,830	14,735
Fish scrap and meal	6,900	12,024	6,965
Other nitrogenous materials	43,048	56,184	65,469
Total nitrogenous materials	967,979	1,090,829	1,062,113
Bone phosphates‡	67,166	78,176	22,966
Superphosphate—not over 20%	7,291	12,147	10,257
Superphosphate—over 20% ..	2,864	4,944	8,406
Superphosphate, ammoniated..	96	147	90
All other phosphates	6,116	3,905	7,697
Total phosphate materials..	83,533	99,319	49,416
Muriate of potash	136,155	84,301	199,378
Kainit, 14%	0	269	355
Kainit, 20%	32,299	18,385	53,407
Manure salts, 30%	395	1,855	8,187
Sulphate of potash	22,333	36,913	53,442
Sulphate of potash-magnesia	3,482	11,259	11,748
Nitrate of potash	1,168	8,449	13,249
Pot.-sodium nitrate mixtures	49,121	49,254	39,556
Other potash materials	112	133	164
Total potash materials ...	245,065	210,818	379,486
Nit-phos-pot. fertilizers	27	2,794	7,384
Other fertilizers	38,038	44,894	55,143
Grand Total	1,334,642	1,448,654	1,553,542

† Chiefly domestic synthetic sodium nitrate. ‡ Includes crude bone in 1939 and 1940.

$20,224,000. Compared with 1939 there was a decline of 8 per cent in tonnage. However, due largely to increased shipments of ammonium sulphate, with a relatively high value per ton, there was a rise of 18 per cent in value, over the previous year.

Principal changes in 1940 exports, as compared with 1939, were: a sharp rise in ammonium sulphate exports, with a shift from a net import balance of 64,000 long tons in 1939 to a net export balance of 109,000 tons in 1940; moderate declines in other nitrogenous materials; a marked drop in exports of land pebble rock which more than offset an increase in hard rock; larger shipments of superphosphate; and a decline in potash exports.

Imports fell off for the third consecutive year, dropping to 1,335,000 long tons valued at $28,688,000. They were 8 per cent less in tonnage and 15 per cent less in value than in 1939.

Potash imports were larger than in the preceding year, but with that exception were the smallest in many years. Muriate and 20 per cent kainit were both imported in larger quantity than in 1939; there was a decline in imports of sulphate of potash. In the nitrogenous group increased imports of sodium nitrate and ammonium phosphates were more than offset by declines in ammonium sulphate, ammonium nitrate mixtures, cyanamide, calcium nitrate, and natural organics.

NEW JERSEY FERTILIZER GRADES

New Jersey grade survey report for the calendar year, 1940, which was compiled jointly by the Association and the New Jersey College of Agriculture, has been released by Dr. Firman E. Bear of the latter institution. The report includes 120,561 tons of mixed fertilizers, 42,230 tons of materials, and 16,116 tons of liming materials. There were 134 grades of mixed goods sold, including 68 grades of which less than 100 tons of each was sold. Sales of the 9 ratios recommended for use in the State by the College of Agriculture amounted to 43,819 tons, or 36 per cent of total mixed goods tonnage. The two leading grades were 4-8-10 and 5-8-7, neither of which was on the recommended list.

Grade	Tons	Per Cent of Mixed Goods
4-8-10	19,177	15.9%
5-8-7	16,014	13.3
5-10-10	13,683	11.3
3-12-6	8,893	7.4
2-8-10	6,634	5.5
5-10-5	5,457	4.5
4-9-7	5,080	4.2
129 grades	45,623	37.9

AYCOCK JOINS CALIFORNIA CHEMICAL CO.

The California Chemical Company, New York City, has announced the appointment of L. M. Aycock to their sales department. Mr. Aycock, who was formerly with F. W. Berk & Company, will concentrate on sales of magnesium oxide to the fertilizer industry, having a wide acquaintance in that branch of business.

JANUARY SULPHATE OF AMMONIA

The production of by-product sulphate of ammonia has apparently reached its maximum level with the present plant equipment. The U. S. Bureau of Mines figures for January, 1941, show a production of 64,670 tons, an increase of only 0.4 per cent over December output of 64,382 tons and less than 7 per cent above January, 1940, total of 60,393 tons.

By-product ammonia liquor produced during January amounted to 2,664 tons (NH_3 content) compared with 2,655 tons in December, 1940, and 2,404 tons in January, 1940.

The fact that by-product coke ovens are working to capacity is evidenced by the increase in coke production from the old-style, wasteful beehive ovens. In January, 1941, the coke output from the latter type of oven was 514,000 tons, compared with 238,300 tons during January, 1940. If this amount of coke could have been produced in modern by-product ovens, there would have been recovered an additional 6,500 tons of sulphate.

LAWN PAMPHLET ISSUED BY N. F. A.

The latest pamphlet issued by the National Fertilizer Association is entitled "Improving Grass in Lawns, Parks, Fairways and Athletic Fields." This pamphlet presents fundamental and yet brief information on improving grass and turf under various conditions. It especially emphasizes fertilizer use for this purpose.

It has been estimated recently that $200,000,000 are spent annually in the United States for maintaining turf. There are 10,000,000 acres in highway shoulders and intersections in this country. The development of airplane fields for the defense program also indicates an intensified use of fertilizer for grass.

It is hoped that publication of this pamphlet will also focus more attention on the importance of fertilizer use in improving recreational areas. The pamphlet is being distributed through sales in quantity to members of the Association.

Wisconsin Fertilizer Sales, 1940

Totaling 64,253 tons, the largest volume of commercial fertilizer ever purchased by Wisconsin farmers in any one year was sold in this state in 1940, the state department of agriculture reports.

This figure represents an increase of about 51 per cent over the 42,623 tons sold in Wisconsin in 1939, more than 25 per cent over the previous all-time high of 51,222 tons reported in 1930, and nearly 300 per cent over the 16,311 tons reported sold in this state in 1933, according to W. B. Griem, senior chemist in charge of the department's feed and fertilizer section.

The total tonnage is determined from reports submitted by fertilizer manufacturers who register their products with the department. The most popular analysis of complete mixed goods was again the 2-12-6 grade, accounting for 14,296 tons or 35 per cent of the tonnage in this classification.

Next in popular demand were the 3-12-12 grade, which accounted for 24 per cent of the tonnage in the mixed goods class; the 3-9-18 and 3-18-9 grades, each of which accounted for 9 per cent, and the 3-14-6 grade, which comprised 8 per cent. These five grades accounted for 85 per cent of the complete mixed goods.

In the phosphate and potash mixtures the 0-20-10 grade, used chiefly for small grains, was most in demand. This grade accounted for 46 per cent of the phosphate and potash mixtures.

The average plant food content of the fertilizer sold in Wisconsin was 26.11 per cent, which was far above the national average and the highest ever recorded in this state.

A notable feature of the fertilizer sales for 1940 was the increase in the use of phosphates, which was chiefly due to the AAA conservation program in which 45 per cent superphosphate was distributed to individuals cooperating in the program. The tonnage of 45 per cent superphosphate distributed in Wisconsin was 2,956 tons in 1940 compared with only 151 tons the preceding year.

The volume of the well-known 20 per cent superphosphate sold in Wisconsin was 5,276 tons in 1940 compared with 3,332 tons in 1939.

In 1940 Wisconsin farmers bought 13,157 tons of phosphate and potash mixture as compared with 7,658 tons the year before, 38 049 tons of mixed goods compared with 28,215 tons in 1939, and 4,815 tons of other material compared with 3,267 tons.

Wisconsin Tonnage by Grades, 1940

Analysis	Tons	Analysis	Tons
2-8-16	3	8-6-2	7
2-9-27	20	6-16-16	29
2-10-30	80	10-6-4	304
2-12-2	845	10-8-4	51
2-12-6	14,296	12-6-4	24
2-16-2	1	0-8-24	125
2-16-8	112	0-9-27	1,660
3-9-18	3,373	0-10-20	256
3-10-30	36	0-10-30	200
3-12-12	9,209	0-12-12	1,198
3-14-6	2,887	0-14-6	31
3-15-18	124	0-14-7	5
3-18-9	3,341	0-14-14	917
4-8-6	483	0-16-6	188
4-8-7	189	0-20-10	6,101
4-8-8	379	0-20-20	2,476
4-10-4	4	0-20-0	5,276
4-10-6	375	0-45-0	2,956
4-12-4	144	Rock phosphate	586
4-13-4	11	Bone meal	76
4-16-4	1,446	Cyanamid	414
4-16-32	7	Manures	172
4-16-40	19	Muriate of potash	747
4-24-12	10	Nitrate of soda	63
5-10-5	35	Organics	1,778
5-12-12	94	Sulphate of ammonia	979
6-8-4	12		
7-7-5	12		
8-5-3	87	Total Tonnage	64,253

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FERTILIZER MATERIALS MARKET

NEW YORK

No Shortage of Potash for Domestic Needs. Amount to Be Allowed for Export Still Uncertain. Triple Superphosphate and Some Organics Scarce.

Exclusive Correspondence to "The American Fertilizer."

NEW YORK, February 27, 1941.

Potash deliveries are continuing as rapidly as possible and the needs of the fertilizer manufacturers will undoubtedly be taken care of during the present season. With the requirement of export licenses for the shipping of potash salts out of the country, in all likelihood exports will be at a low figure, as officials in Washington are fearful of a considerable shortage of potash for domestic needs for the new season. However, from present indications, with the anticipated productions of the newer companies, all domestic requirements should be fully taken care of with ease.

Sulphate of Ammonia

Continues scarce, but again there should be ample stocks available for domestic needs for the new season, as in all likelihood export licenses will become more and more difficult to obtain for shipment of this commodity for most destinations.

Nitrate of Soda

There is no change in the regular price of $27.00 in bulk, $28.70 in 200 lb. bags, and $29.40 in 100 lb. bags.

Superphosphate

The price situation remains unchanged with ample material available. Triple superphosphate demand continues strong, and with requirements from the English being taken care of from here, this material will continue scarce throughout the year.

Potash

The market price today is 53½ cents per unit, no discount; regular conditions.

Bone Meal

South American 4½ and 45 per cent raw bone is still quoted at $32.00, c.i.f., but difficulty in securing freight space makes it hard to work business, even at this price.

Nitrogenous

Steady, prices strictly nominal, no new business to report.

Tankage

Easy tone in local market, with unground 9/10 per cent material workable at $2.30 ($2.79½ per unit N).

Dried Blood

Continues to show decline with business being done this week at $2.60 ($3.16 per unit N), and it is possible to obtain additional supplies at the same figure.

Fish Scrap

No activity in this commodity, occasioned by the lack of offerings of either Japanese or domestic material .

BALTIMORE

Manufacturers Prepared for Spring Shipping Season. Materials Market Quiet but Firm.

Exclusive Correspondence to "The American Fertilizer."

BALTIMORE, February 25, 1941.

On the eve of the spring shipping season for which all manufacturers are now ready and prepared, there is practically no new business being booked, and probably will not be until after the spring season gets well under way. In the meantime, the market is holding fairly firm.

Ammoniates.—There is practically no demand for fertilizer purposes, but the price of tankage for feeding is unchanged, at $3.10 per unit of nitrogen, while the market on South American blood is nominally $3.20 per unit of nitrogen, c.i.f. Baltimore

Nitrogenous Material.—There is no change, and these goods continue to be quoted at $2.55 to $2.65 per unit of nitrogen, f.o.b. Baltimore.

Sulphate of Ammonia.—These goods are still in short supply, and the limited tonnage

FERTILIZER MATERIALS

LET US QUOTE YOU ON YOUR REQUIREMENTS OF THESE MATERIALS

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SUPERPHOSPHATE
DOUBLE SUPERPHOSPHATE
NITRATE *of* SODA
SULPHURIC ACID
SULPHATE *of* AMMONIA
BONE MEALS
POTASH SALTS
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TANKAGES
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Wilmington, N. C.

available for export is only quoted for future delivery at prices ranging from $42.50 to $45.00 per ton, f.a.s. Baltimore

Nitrate of Soda.—There has been a seasonal improvement in the demand, and this will doubtless increase as the season advances. Champion Brand, Chilean, is still quoted at $29.40 per ton of 2,000 lb., packed in 100 lb. bags, ex port warehouse, with usual differential for 200 lb. bags and in bulk.

Fish Meal.—This material is in short supply, and there are occasional offerings which range from $59.00 to $60.00, f.o.b. Baltimore.

Superphosphate.—The market is unchanged at $8.00 per ton of 2,000 lb. for run-of-pile, basis 16 per cent, and $8.50 for flat 16 per cent grade, both in bulk, f.o.b. producers' works, Baltimore, with no change in prospect during the spring season.

Bone Meal—The demand for raw and steamed bone meal is practically nil on account of the comparatively high prices prevailing. 3 and 50 per cent steamed bone meal is quoted at $32.00 to $34.00 per ton, according to mechanical condition, f.o.b. Baltimore, while South American 4½ and 47 per cent is still quoted at $31.00 to $32.00 per ton, f.o.b. Baltimore.

Potash.—Up to the present time there has been practically no demand for resale, and most manufacturers have ample supplies on hand to carry them through for their normal requirements during the present spring season.

Bags.—Due to the difficulties in securing freight room, a shortage of burlap has resulted, with consequent higher prices on bags. For spring delivery the price of 10 oz., 40 cut 54 in., is about $141.00 per thousand, which represents an advance of about $13.50 per thousand since last report, but most of the manufacturers have already covered for the major portion, if not all, of their requirements for the coming spring season.

ATLANTA

Greater Interest in Material Purchases Shown. High Freights Raise Prices of Imported Materials.

ATLANTA, February 24, 1941.

With the spring fertilizer shipping season in the offing, interest in materials is becoming more manifest. There is a steady demand for sulphate of ammonia with very little material coming out except a few resales now and then.

Ocean freights are still advancing and incoming supplies from South America are gradually demanding a higher price to take care of the added transportation costs. Recent freights from the Argentine on fertilizer mate rials have been booked at $16.00 per ton, whereas previous bookings were at $12.00. Even so. the steamship lines are giving preference to other cargo which pays better.

Cottonseed meal for March delivery is now quoted around $23.00 to $24.00 basis f.o.b. Memphis with southeastern meal about $2.00 per ton higher.

Peanut meal is still available in south Georgia and southwest Alabama at $21.00 f.o.b. producing mills, this price being several dollars per ton under the cottonseed parity. Peanut meal is guaranteed 8.75 per cent ammonia.

Nitrate of soda is beginning to move in certain sections and with the scarcity of sulphate of ammonia, the demand for this product should be extremely active throughout the balance of the spring fertilizer season.

The demand for potash is fairly active, with very little resale material at less than the scale being available. Producers and importers all claim to be well sold up.

Nitrogenous tankage in the Middle West is now quoted at $1.85 ($2.25 per unit N) producing points, a reduction of 10 cents per unit from recent prices; but even so, the demand is limited for the time being.

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CHARLESTON

Mixing Season About to Start. Some Materials in Short Supply.

Exclusive Correspondence to "The American Fertilizer."

CHARLESTON, S. C., February 24, 1941

The movement of mixed fertilizers has just barely begun and the manufacturers expect to be quite busy in the next week or ten day in this section. Chilean nitrate of soda has begun to move. Sulphate of ammonia continues extremely scarce and also the liquid ammonias. Potash supplies are hard to locate.

Nitrogenous.—Domestic can be obtained around $2.40 ($2.91½ per unit N), delivered southeastern ports.

Blood.—Around $2.85 ($3.46½ per unit N) Chicago, bulk; $2.52 ($3.06 per unit N) c.i.f. Atlantic ports, in bags, but freights can hardly be worked to any ports south of Norfolk or Baltimore.

Tankage.—Fertilizer grade, around $2.85 ($3.46½ per unit N) and 10 cents, f.o.b. Chicago.

Fish Meal.—Supplies of all kinds of fish remain exceedingly scarce.

Cottonseed Meal.—Around $30.00 for 8 per cent at Atlanta, and $23.75 for 8 per cent at Memphis.

CHICAGO

Fertilizer Organics Market Holding Firm in Spite of Little Buying Interest. Feed Material Prices Reduced.

Exclusive Correspondence to "The American Fertilizer."

CHICAGO, February 24, 1941.

Trading in organics has been in relatively small amounts and has had but little effect on the market. Sellers stubbornly believe that demand for a fair sized tonnage will develop before the season progresses much further. With buying interest narrow and with no increased tonnage coming into the market, the present stalemate may continue for some time. Shipping orders on old contracts are coming in steadily, indicating a fairly good southern season.

List prices of digester tankage and meat scraps were recently reduced, and thereby caused a decline in the feed materials market.

Nominal prices are as follows: High grade ground fertilizer tankage, $2.20 to $2.25 ($2.67½ to $2.73½ per unit N) and 10 cents; standard grades, crushed feeding tankage, $2.75 to $2.85 ($3.34½ to 3.46½ per unit N)

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UNITED STATES POTASH COMPANY, INC.
30 ROCKEFELLER PLAZA
NEW YORK, N. Y.

and 10 cents; blood, $2.75 to $2.85 ($3.34½ to $3.46½ per unit N); dry rendered tankage, 55 to 60 cents per unit of protein, Chicago basis.

TENNESSEE PHOSPHATE

Good Weather Aids Phosphate Mining and Crop Preparations. Phosphate Plants Being Remodelled.

Exclusive Correspondence to "The American Fertilizer."

COLUMBIA, TENN., February 24, 1941.

Farmers and outside miners have enjoyed more workable days so far this winter than are usually experienced here, and somewhat similar conditions must have prevailed over a considerable part of the area where farmers use ground phosphate rock for direct application, judging from the very large increase of January and February shipments to that consuming channel.

Farmers here are far ahead of usual condition with their work. Spring plowing, oat and clover seeding, tobacco bed planting and Irish potato planting are far along, and one of the best crops of lambs in years is enjoying wonderful winter pasture that has been most abundant.

The IAC plant at Mt. Pleasant has been securing supplies by truck from tracts owned near Mt. Pleasant and more recently has been conducting similar operations on the lands owned by the company at Southport. Hauling the crude run-of-mines material through Mt. Pleasant, a distance of about twelve miles and about four hundred truck loads a day, has given an appearance of greater mining activity than the phosphate city has had for some time.

The Charleston Mining Co. and the Federal Chemical Co. both completed entire remodelling of their plants some weeks ago. The Hoover & Mason Phosphate Co. is making most extensive changes and improvements in their washer approach from the mines, with an elevated trestle over a very long pit, into which the mine cars dump, permitting selective storage, ahead of the washer, of different grades of material. This will then be fed to conveyor into the washer, by Sauerman drags, doing away with the skip hoist similar to blast furnace feed, which has been a characteristic of that plant for 26 years.

The many friends of Mr. and Mrs. G. L. Davidson, of Chattanooga, Tenn., were shocked and grieved to learn of the death of both on February 22nd at their home. Mrs. Davidson was a niece of Mrs. John Ruhm, Jr., of Mt. Pleasant, and Mr. Davidson was a chemical engineer of high standing, having been with the Hoover & Mason Phosphate Co. from their advent in the Tennessee field in 1909. He was General Manager of the Ruhm Phosphate Min ing Co., and designed and operated their hydraulic mining and washing plant at Mt. Pleasant. During the World War I, he organized the Southern Ferro-Alloys Co., and operated it until a few years ago when ill health caused his retirement. Both Mr. and Mrs. Davidson have been in very bad health for several years prior to their death. They are survived by one daughter, Miss Zenora Davidson, of Chattanooga.

U. S. AMMONIA PLANT TO BE CONSTRUCTED

The War Department has awarded the contract for the construction and operation of its new synthetic ammonia plant to the Atmospheric Nitrogen Corporation, a subsidiary of the Allied Chemical & Dye Company. The contract, which was approved by the Office of Production Management, totals $15,484,195 on a cost-plus-fixed-fee basis. Of this amount, $13,600,000 represents the cost of design, construction and equipment, the remainder, $1,884,195, being for operation.

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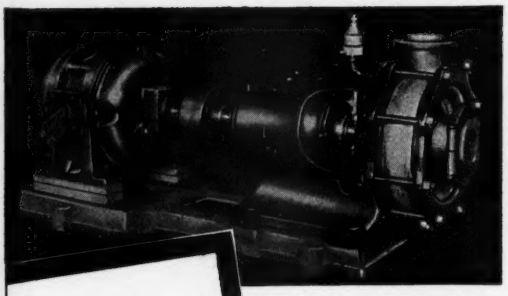

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THE EGNER LACTATE METHOD FOR PHOSPHATE DETERMINATION

(Continued from page 7)

chloric acid is added. The solution should be clear, if the lactate is of good quality. It is then diluted to 2 liters, and a few drops of chloroform added to prevent mold growth (mercury and toluene were tried for the same purpose, but without success; with chloroform, the solution keeps clear for months. A small amount of mold does not matter).

B. *The extraction liquid* is prepared by diluting 1 volume of sol. A to 25 volumes with distilled water. Great precision in diluting is unnecessary. A large storage bottle (e.g., 15 liters) with a thick pencil mark might be used.

C. *Standard phosphate.* O.192 g.KH_2PO_4 is dissolved in distilled water and diluted to 1 liter. C1, C2, C3, etc., are *the standards.* C5, for instance, is made up by taking 5 ml. of solution C, adding water and 20 ml. of solution A, and diluting to 500 ml. C15 is made by taking 15 ml. of C, 20 ml. of A, diluting to 500 ml., etc. The following standards were used: C0, C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C12.5, C15 and C20.

D. *Molybdate solution.* 50 g. of crystallized ammonium molybdate is dissolved in 500 ml. water in a 2 liter volumetric flask. 500 ml. concentrated sulphuric acid is added to 500 ml. water in another flask, with cooling. When both are cool, the sulphuric acid is added slowly and with shaking to the molybdate solution, and the mixture diluted to 2 liters. This solution is conveniently stored in a brown bottle, fitted with a burette. Naturally, rubber tubing must not come in contact with the solution, and the burette must be cleaned with water after use.

E. *Stannous chloride.* 5 g. crystallized stannous chloride is dissolved in 250 ml. 10% hydrochloric acid, and diluted to 500 ml. The solution is stored in small medicine glass bottles (e.g. 50 ml.), which are filled to the neck and fitted with tight rubber stoppers. In this way, stannous chloride might be kept almost indefinitely without changing its titre.

To make a series of phosphate estimations, 25 ml. of the soil extracts are pipetted into 50 ml. medicine bottles, as mentioned before. 50 to 60 samples might be taken at the same time, as the fading is rather slow. 25 ml. of the solutions C0, C1 . . . C20 are pipetted to the same kind of bottles. To each of these bottles, 1 ml. of solution D and 0.5 ml. of solution E is added. As a small variation in the amount of solution D makes a considerable change in color, the measuring of this solution must be made with reasonable care; an error of 0.05 ml. is permissible, not more. The bottles are shaken a little after each addition, and set aside a couple of minutes. Full color is developed after about 3 minutes at a room temperature of 18° C. (65°F.) and will be practically constant for 15 to 20 minutes. The color comparison is made by help of a light box. When two persons collaborate, one portions out the molybdate solution, the other the stannous chloride. Thereafter one reads the color, and the other writes down the figures. Thus, a series of at least 70 tests might be analyzed in less than 30 minutes. The numbers of the standards mean g. P_2O_5 per 100 g. of soil, and this amount might be estimated to about 0.2 units, in the poor soils.

As a preliminary figure, it might be mentioned that less than 200 kg. of lactate-soluble phosphoric acid per hectare (178 lb. per acre) almost always denotes a poor soil, while more than 200 kg. denotes a rich soil.

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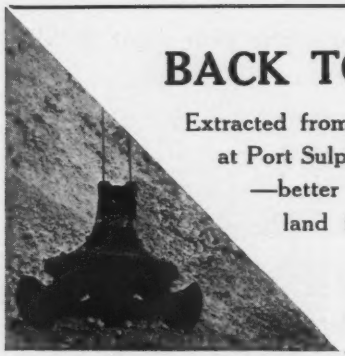

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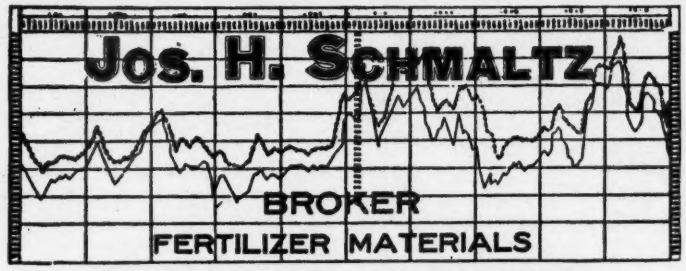

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LIEBIG AND OUR NITROGEN INDUSTRY

(Continued from page 11)

produced 676,800 tons of sulphate of ammonia. Because of increased need for steel, the output of coke has been steadily stepped up in recent months, with consequent increased production of sulphate of ammonia—60,718 tons being the output in July, 1940, a 30 per cent increase over July of last year.

Nitrate of soda was imported to the extent of 650,000 tons in 1937, and 150,000 tons were manufactured synthetically. A recent news item announced that the capacity for domestic synthetic production of nitrate of soda was being increased 15 per cent. Ammonia solutions synthetically produced by the fixation of atmospheric nitrogen and containing also ammonium nitrate or urea were consumed in the amount of 40,000 tons of nitrogen in 1937.

Our synthetic nitrogen industry consists of two large and at least seven small plants for the fixation of atmospheric nitrogen as ammonia. Both the large plants are reported to be greatly expanding their capacity to meet present emergency demands. This expansion is being accomplished partly by completion of new units and partly by the conversion of similar equipment hitherto used for the production of other synthetic commodities.

In the press discussion of the present defense program we see frequent suggestions that new large synthetic nitrogen plants will be constructed by the Government for the production of explosives. One synthetic ammonia plant at an estimated cost of $15,000,000 and two ammonium nitrate plants at a cost of $9,000,000 each are said to be included in the Ordnance Department program. Such plants will be entirely superfluous in our peace time economy since present capacity is sufficient in such times. The emergency need seems to be for nitric acid for the manufacture of TNT, ammonium nitrate, smokeless powder, guncotton, and similar explosives. In an emergency it would seem quicker, easier, and cheaper to produce nitric acid from nitrate of soda imported from Chile. The process is simple, and plants can be quickly and cheaply built. There would be no necessity for enormous investments in plants which must lie idle in peace time or be forced into the production of nitrogen compounds in competition with private industry. The use of Chilean nitrate for this purpose would be of incalculable benefit to that country and would seem to be a well worth-while national action to foster international relationships.

It is to be remembered also that the production of nitrogen compounds by the fixation of atmospheric nitrogen is a difficult and complex operation. Any inexperienced Government agency (and no Government agency is experienced in these processes) must necessarily spend considerable time and effort in the study of designs and methods of operation. Delays under emergency demands are dangerous. If it be determined that our national defense requires additional capacity for the fixation of atmospheric nitrogen, such plants should be designed, constructed, and operated by those firms in private industry that are already experienced in the process involved and that can furnish experienced skeleton crews for their operation.

Our nitrogen industry has gone far since Liebig's day. It is efficient, economical, and adequate for all peace-time needs, with sufficient excess capacity to meet an ordinary emergency. That it is efficient and economical is evidenced by the fact that there has been a reduction of almost 50 per cent in the price of fertilizer nitrogen in the last 15 years. It is competent to build and operate the additional plants that may be needed for any national emergency.

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Bagpak, Inc., New York City.
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS—Cotton
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS—Paper
Bagpak, Inc., New York City.
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS (Waterproof)—Manufacturers
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS—Dealers and Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

BAGGING MACHINES—For Filling Sacks
Atlanta Utility Works, East Point, Ga.
Bagpak, Inc., New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

BAG-CLOSING MACHINES
Bagpak, Inc., New York City.

BAG PILERS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.

BEARINGS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

BELT LACING
Sackett & Sons Co., The A. J., Baltimore, Md.

BELTING—Chain
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

BELTING—Leather, Rubber, Canvas
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

BOILERS—Steam
Atlanta Utility Works, East Point, Ga.

BONE BLACK
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Huber & Company, New York City.

BONE PRODUCTS
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

BORAX AND BORIC ACID
American Potash and Chem. Corp., New York City.
Pacific Coast Borax Co., New York City.

BROKERS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Keim, Samuel L., Philadelphia, Pa.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

BUCKETS—Elevator
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

HENRY L. TAYLOR, *Broker*
Bentley's Code Cable Address "HLTAYLOR"
NORTH CAROLINA BANK BLDG., WILMINGTON, N. C.
Menhaden Fish Products and Fertilizer Materials

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BUCKETS—For Hoists, Cranes, etc., Clam Shell, Orange Peel, Drag line, Special; Electrically Operated and Multi Power
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

BURNERS—Sulphur
Chemical Construction Corp., New York City.

BURNERS—Oil
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.

CABLEWAYS
Hayward Company, The, New York City.

CARBONATE OF AMMONIA
American Agricultural Chemical Co., New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.

CARS—For Moving Materials
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CARTS—Fertilizer, Standard and Roller Bearing
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

CASTINGS—Acid Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.

CASTINGS—Iron and Steel
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CEMENT—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

CHAIN DRIVES—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAINS AND SPROCKETS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAMBERS—Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CHEMICAL APPARATUS
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

CHEMICALS
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.
Bradley & Baker, New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.

CHEMICALS—Continued
Huber & Company, New York City.
Phosphate Mining Co., The, New York City.
Wellmann, William E., Baltimore, Md.

CHEMICAL PLANT CONSTRUCTION
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHEMISTS AND ASSAYERS
Gascoyne & Co., Baltimore, Md.
Shuey & Company, Inc., Savannah, Ga.
Stillwell & Gladding, New York City.
Wiley & Company, Baltimore, Md.

CLUTCHES
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CONCENTRATORS—Sulphuric Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CONDITIONERS AND FILLERS
American Limestone Co., Knoxville, Tenn.
Phosphate Mining Co., The, New York City.

CONTACT ACID PLANTS
Chemical Construction Corp., New York City.

COPPER SULPHATE
Tennessee Corporation, Atlanta, Ga.

COTTONSEED PRODUCTS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

CRANES AND DERRICKS
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill., and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

CYANAMID
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

DENS—Superphosphate
Chemical Construction Corp., New York City.
Stedman's Foundry and Mach. Works, Aurora, Ind.

Andrew M. Fairlie
CHEMICAL ENGINEER
22 Marietta Street Building ATLANTA, GA.
CABLE ADDRESS: "SULFACID ATLANTA"

SULPHURIC Acid Plants . . . Design, Construction, Equipment . . . Operation . . . Mills-Packard Water-Cooled Acid Chambers, Gaillard Acid-Cooled Chambers, Gaillard Acid Dispersers, Contact Process Sulphuric Acid Plants.

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DRYERS—Direct Heat
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

DRIVES—Electric
Link-Belt Company, Philadelphia, Chicago.

DUMP CARS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

DUST COLLECTING SYSTEMS
Sackett & Sons Co., The A. J., Baltimore, Md.

ELECTRIC MOTORS AND APPLIANCES
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

ELEVATORS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ELEVATORS AND CONVEYORS—Portable
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

ENGINEERS—Chemical and Industrial
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ENGINES—Steam
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

EXCAVATORS AND DREDGES—Drag Line and Cableway
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link Belt Speeder Corp., Chicago, Ill., and Cedar Rapids, Iowa.

FERTILIZER MANUFACTURERS
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Farmers Fertilizer Co., Columbus, Ohio
International Agricultural Corp., New York City.
Phosphate Mining Co., The, New York City.
U. S. Phosphoric Products Division, Tennesee Corp., Tampa, Fla.

FISH SCRAP AND OIL
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

FOUNDERS AND MACHINISTS
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GARBAGE TANKAGE
Wellmann, William E., Baltimore, Md.

GEARS—Machine Moulded and Cut
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GEARS—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

GELATINE AND GLUE
American Agricultural Chemical Co., New York City.

GUANO
Baker & Bro., H. J., New York City.

HOISTS—Electric, Floor and Cage Operated, Portable
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.

HOPPERS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

IMPORTERS, EXPORTERS
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

IRON SULPHATE
Tennessee Corporation, Atlanta, Ga.

INSECTICIDES
American Agricultural Chemical Co., New York City.

LACING—Belt
Sackett & Sons Co., The A. J., Baltimore, Md.

LIMESTONE
American Agricultural Chemical Co., New York City.
American Limestone Co., Knoxville, Tenn.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

LOADERS—Car and Wagon, for Fertilizers
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Acid Making
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Duriron Co., Inc., The, Dayton, Ohio.
Fairlie, Andrew M., Atlanta, Ga.
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Coal and Ash Handling
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Elevating and Conveying
Atlanta Utility Works, East Point, Ga.
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

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MACHINERY—Power Transmission
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Pumping
Atlanta Utility Works, East Point, Ga.
Duriron Co., Inc., The, Dayton, Ohio.

MACHINERY—Tankage and Fish Scrap
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MAGNETS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MANGANESE SULPHATE
McIver & Son, Alex. M., Charleston, S. C.
Tennessee Corporation, Atlanta, Ga.

MIXERS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.
Bradley & Baker, New York City.
Chilean Nitrate Sales Corp., New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

NITRATE OVENS AND APPARATUS
Chemical Construction Corp., New York City.

NITROGENOUS ORGANIC MATERIAL
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
DuPont de Nemours & Co., Wilmington, Del.
Huber & Company, New York City.
International Agricultural Corp., New York City.
McIver & Son, Alex. M., Charleston, S. C.
Smith-Rowland Co., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

NOZZLES—Spray
Monarch Mfg. Works, Philadelphia, Pa.

PACKING—For Acid Towers
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

PANS AND POTS
Stedman's Foundry and Mach. Works, Aurora, Ind.

PHOSPHATE MINING PLANTS
Chemical Construction Corp., New York City.

PHOSPHATE ROCK
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
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Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Phosphate Mining Co., The, New York City.
Ruhm, H. D., Mount Pleasant, Tenn.
Schmaltz, Jos. H., Chicago, Ill.
Southern Phosphate Corp., Baltimore, Md.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

PIPE—Acid Resisting
Duriron Co., Inc., The, Dayton, Ohio.

PIPES—Chemical Stoneware
Chemical Construction Corp., New York City.

PIPES—Wooden
Stedman's Foundry and Mach. Works, Aurora, Ind.

PLANT CONSTRUCTION—Fertilizer and Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

POTASH SALTS—Manufacturers and Importers
American Potash and Chem. Corp., New York City.
Potash Co. of America, Baltimore, Md.
United States Potash Co., New York City.

PULLEYS AND HANGERS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

PUMPS—Acid-Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PYRITES—Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., New York City.
Jett, Joseph C., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

QUARTZ
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

RINGS—Sulphuric Acid Tower
Chemical Construction Corp., New York City.

ROUGH AMMONIATES
Bradley & Baker, New York City.
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SCRAPERS—Drag
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Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

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Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SEPARATORS—Air
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Including Vibrating
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Magnetic
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHAFTING
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHOVELS—Power
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill., and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

SPROCKET WHEELS (See Chains and Sprockets)

STACKS
Sackett & Sons Co., The A. J., Baltimore, Md.

SULPHATE OF AMMONIA
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Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
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Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
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Freeport Sulphur Co., New York City.
Texas Gulf Sulphur Co., New York City.

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American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.

SULPHURIC ACID—Continued
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE
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Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE—Concentrated
Armour Fertilizer Works, Atlanta, Ga.
International Agricultural Corp., New York City.
Phosphate Mining Co., The, New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

SYPHONS—For Acid
Monarch Mfg. Works, Inc., Philadelphia, Pa.

TALLOW AND GREASE
American Agricultural Chemical Co., New York City.

TANKAGE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Smith-Rowland, Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

TANKAGE—Garbage
Huber & Company, New York City.

TANKS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons, Co., The A. J., Baltimore, Md.

TILE—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

TOWERS—Acid and Absorption
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

UNLOADERS—Car and Boat
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

UREA
DuPont de Nemours & Co., E. I., Wilmington, Del.

UREA-AMMONIA LIQUOR
DuPont de Nemours & Co., E. I., Wilmington, Del.

VALVES—Acid-Resisting
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
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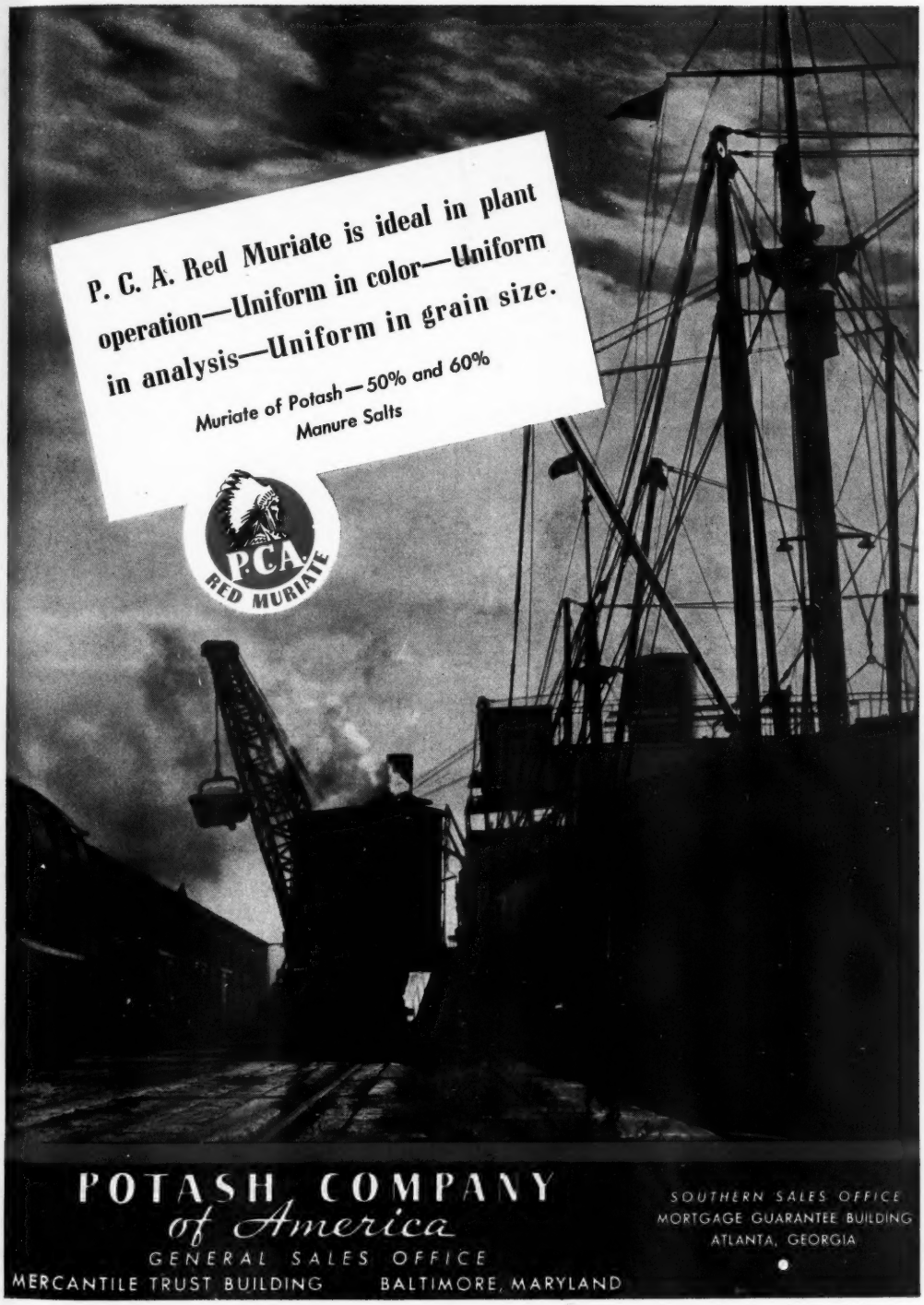
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